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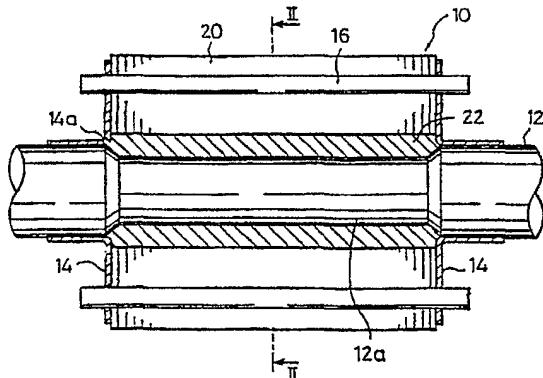
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(54) ROTOR STRUCTURE OF THE RADIAL TYPE.

(57) In the rotor structure of a synchronous motor of the radial type having a shaft (12) composed of a magnetic material and in which rotor core members (20) are held by magnets (18), the magnetic shaft (12) causes a leakage of the fluxes during its magnetization or the rotation of the rotor, thereby degrading the magnetizing property and output performance. Therefore, the leakage of magnetic flux is decreased by decreasing the diameter of a shaft portion (12a) that faces the inner surface of the rotor body (10). The decrease in the resistance of the shaft (12) to bending is compensated for by filling the gap between the rotor body (10) and the shaft portion (12a) with a resin material (22) and by forming a knot (24).

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Fig. 1



## TECHNICAL FIELD

The present invention relates to a structure of the radial type rotor in a synchronous type motor, which has a shaft comprised of a magnetic material and which holds the rotor core by magnets.

## BACKGROUND ART

In general, rotor shafts are high in strength and are made using inexpensive ferrous bar materials. In a rotor of a radial type where the rotor core is held by magnets, however, the existence of a ferrous shaft, which is a ferromagnetic body, results in a smaller density of magnetic flux passing through the magnet portions close to the shaft upon magnetization and thus causes incomplete magnetization. Further, after magnetization, when turning the rotor so as to obtain the torque output for the motor, the magnetic flux leaks to the shaft and therefore it sometimes is not possible to obtain a desired torque output.

To reduce the leakage of magnetic flux at the magnetization and the output rotation, the shaft material has been made stainless steel or other nonmagnetic materials and the region of the shaft opposing the magnets has been made smaller.

Stainless steel, however, is expensive and by making the shaft smaller in diameter, the strength of the shaft is remarkably reduced.

## DISCLOSURE OF THE INVENTION

Accordingly, to resolve the above problems, an object of the present invention is to provide a rotor structure which raises the magnetization of the magnets and raises the torque output without reducing the strength of the shaft, at low cost.

In consideration of the above object, there is provided a structure of the radial type rotor which has a shaft comprised of a magnetic material and has a rotor core held by magnets, said structure of the radial type rotor characterized in that the portion of the shaft opposing the rotor body is formed to be narrower than other portions and the gap between the narrow portion of the shaft and the said rotor body is filled with a resin material which is then cured.

Further, it provides a structure of the radial type rotor characterized in that a thin node is formed at the above-mentioned narrow portion regardless of the presence or absence of the above-mentioned resin material.

Although the shaft is comprised of iron or another high strength magnetic material, the portion opposing the rotor body is made narrow so that it is possible to reduce the leakage of magnetic flux

from the magnet portion to the shaft both upon magnetization and upon rotation of the rotor. In this case, the shaft is reinforced in strength by filling and curing a resin material in the gap between the said shaft and the rotor body.

Further, instead of filling a resin material, it is possible to provide a node at the narrow portion of the shaft and have the node abut against the inner circumference of the rotor when a bending force acts on the shaft so as to enable the bending force to be withstood.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a lateral sectional view of a rotor according to the present invention;  
 Fig. 2 is a longitudinal sectional view along the arrow line II-II of Fig. 1;  
 Fig. 3 is a lateral sectional view showing another embodiment of the rotor according to the present invention; and  
 Fig. 4 is a longitudinal sectional view along the arrow line IV-IV of Fig. 3.

## BEST MODE FOR CARRYING OUT THE INVENTION

Below, a more detailed explanation will be made of the present invention based on the embodiments shown in the attached drawings. First, referring to Fig. 1 and Fig. 2, a rotor core 20 comprised of laminated plates and held by magnets 18 is held by end plates 14 at its two ends in the longitudinal direction along with the magnets 18, and, further, is penetrated and held by rods 15 to thus form a rotor body 10. Through this rotor body 10 is inserted a shaft 12, which is tightened to form the rotor. The portion opposing the rotor body 10 is a narrow shaft portion 12a formed to be small in diameter. The radial type of rotor shown in this figure is assembled in this way and then magnetized. At that time, to prevent the presence of the shaft 12 made of the low cost ferrous ferromagnetic material from causing leakage of magnetization magnetic flux to the magnets 18, the region opposing the rotor body 10, that is, the region opposing the magnets 18, is formed to be smaller in diameter so as to be distanced from the inner circumferential surface of the rotor 10.

If a bending force acts on the shaft, however, deflection inversely proportional to the fourth power of the diameter occurs, so there is a major problem in the strength of the shaft if it is left small in diameter. Therefore, in the present invention, for example, liquid resin, for example, epoxy resin, is poured from a hole 14a provided in the end plate 14 so as to fill the gap between the rotor body 10

and the narrow shaft portion 12a. This is cured to form a resin layer 22 and thus reinforce the shaft 12.

As a means for reinforcing the shaft 12 against bending force, for example, the method shown in Fig. 3 and Fig. 4 may be used. That is, a thin and annular node 24 is formed near the center of the narrow portion 12a. When the shaft 12 is bent, the node 24 abuts against the inner circumferential surface of the rotor body 10 and the rigidity of the rotor body 10 enables the shaft 12 from being bent more than that. In this case, the dimension of the gap between the outer circumference of the node 24 and the inner circumference of the rotor 10 must be set below the amount of allowable deflection of the shaft 12, but the outer diameter dimension of the node 24 cannot always be set to the convenient dimension due to limitations of assembly of the shaft 12 into the rotor body 10 etc. Therefore, the rotor 10 has mounted to it an annular plate member 26 comprised of a nonmagnetic material at a position where the shaft 12 opposes the node 24, and the inner diameter dimension of the inner circumference 26a of the annular plate 26 is set, with respect to the outer diameter dimension of the outer circumference 24a of the node 24, to a dimension determined by the amount of allowable deflection of the shaft 12. The inherent object of the present invention is to reduce the amount of leakage of magnetic flux from the magnets due to the presence of the shaft 12 made of a ferromagnetic material, so the above-mentioned node 24 is desirably formed thin within the range where it can perform its reinforcing action. Further, the inner diameter dimension of the annular plate 26 formed of a nonmagnetic material is preferably made small, within the range not obstructing the work of inserting and assembling the shaft 12 into the rotor body 10, and the outer diameter dimension of the node 24 of the shaft is preferably made correspondingly small. Further, not just one set of the above-mentioned node 24 and annular plate 25, but, in accordance with need, several sets may be provided, but provision, to the extent possible, at the center of the rotor body 10 in the longitudinal direction effectively prevents deflection of the shaft 12 and acts to reinforce the shaft 12.

When the above node 24 is used, it is not always necessary to fill and cure a resin in the gap between the narrow portion 14a of the shaft 12 and the rotor body 10, but it is desirable to fill and cure resin to make the reinforcement of the shaft 12 more complete. In this case, it is desirable, for pouring liquid resin from the hole 14a of the end plate 14 and filling the resin in all of the gap, to provide holes 26b in the inner circumference 26a of the annular plate 26 to serve as channels for the

liquid resin. The holes 26b are shown in Fig. 4. Channel holes may be provided in the node 24 as well. There is no inherent need for the node 24 to be a perfect annular shape. For example, notches may be provided every 60 degrees of angle. In this case, the notches act as the channel holes. Further, when forming the annular plate 26 by punching, the above-mentioned channel holes 26b may be punched out simultaneously.

Comparing the value found by analysis of the magnetic flux density at the inner circumferential portion of the magnets near the narrow portion of the shaft upon magnetization in the rotor structure of the present invention shown in Fig. 1 with the value of analysis of a rotor structure with a shaft without a narrow portion, it was confirmed that the magnetic flux density was increased about 7 percent. In the above, the explanation was made of only the magnetization, but the same applies to leakage of magnetic flux caused by the magnets after magnetization in a motor using a rotor having the structure of the present invention after magnetization is completed. Therefore, the output torque of the rotor according to the present invention becomes larger than that of a rotor having a shaft without a narrow portion.

As clear from the above explanation, according to the present invention, it is possible to provide a rotor structure which is inexpensive and free of almost any reduction in strength and which improves both the magnetization performance and output performance.

#### EXPLANATION OF REFERENCE NUMERALS

|    |        |                                  |
|----|--------|----------------------------------|
| 35 | 10...  | rotor body                       |
|    | 12...  | shaft                            |
|    | 12a... | narrow shaft portion             |
|    | 22...  | resin layer                      |
|    | 24...  | node                             |
|    | 26...  | annular plate                    |
|    | 26b... | hole for channeling resin liquid |

#### Claims

- 45 1. A structure of the radial type rotor which has a shaft comprised of a magnetic material and has a rotor core held by magnets, said structure of the radial type rotor characterized in that the portion of the shaft opposing the rotor body is formed to be narrower than other portions and the gap between the narrow portion of the shaft and said rotor body is filled with a resin material which is then cured.
- 50 2. A structure of the radial type rotor which has a shaft comprised of a magnetic material and has a rotor core held by magnets, said rotor

structure of the radial type characterized in  
that the portion of the shaft opposing the rotor  
body is formed to be narrower than other portions  
and a thin node is formed at said narrow  
portion.

3. A structure of the radial type rotor according to  
claim 2, wherein said node is formed at a  
center position of the narrow portion.  
5
4. A structure of the radial type rotor according to  
claim 2, wherein a gap between the narrow  
portion of the shaft and the rotor body is filled  
with a resin material which is then cured.  
10
5. A structure of the radial type rotor according to  
claim 3, wherein a gap between the narrow  
portion of the shaft and the rotor body is filled  
with a resin material which is then cured.  
15
6. A structure of the radial type rotor according to  
claim 2, wherein an annular plate comprised of  
a nonmagnetic material is made to be held by  
the rotor body at a position of the rotor body  
corresponding to the position of the node and  
the inner diameter dimension of the annular  
plate is made so that there is a suitable clear-  
ance with the outer diameter dimension of said  
node.  
20
7. A structure of the radial type rotor according to  
claim 3, wherein an annular plate comprised of  
a nonmagnetic material is made to be held by  
the rotor body at a position of the rotor body  
corresponding to the position of the node and  
the inner diameter dimension of the annular  
plate is made so that there is a suitable clear-  
ance with the outer diameter dimension of said  
node.  
25
8. A structure of the radial type rotor according to  
claim 4 wherein an annular plate comprised of  
a nonmagnetic material is made to be held by  
the rotor body at a position of the rotor body  
corresponding to the position of the node and  
the inner diameter dimension of the annular  
plate is made so that there is a suitable clear-  
ance with the outer diameter dimension of said  
node.  
30
9. A structure of the radial type rotor according to  
claim 5, wherein an annular plate comprised of  
a nonmagnetic material is made to be held by  
the rotor body at a position of the rotor body  
corresponding to the position of the node and  
the inner diameter dimension of the annular  
plate is made so that there is a suitable clear-  
ance with the outer diameter dimension of said  
node.  
35
10. A structure of the radial type rotor according to  
any one of claims 4, 5, 8, and 9, wherein said  
node has channel holes formed therein for  
passage of said resin material.  
40
11. A structure of the radial type rotor according to  
claim 8 or claim 9, wherein said annular plate  
has channel holes formed therein for passage  
of said resin material.  
45

50

55

Fig. 1

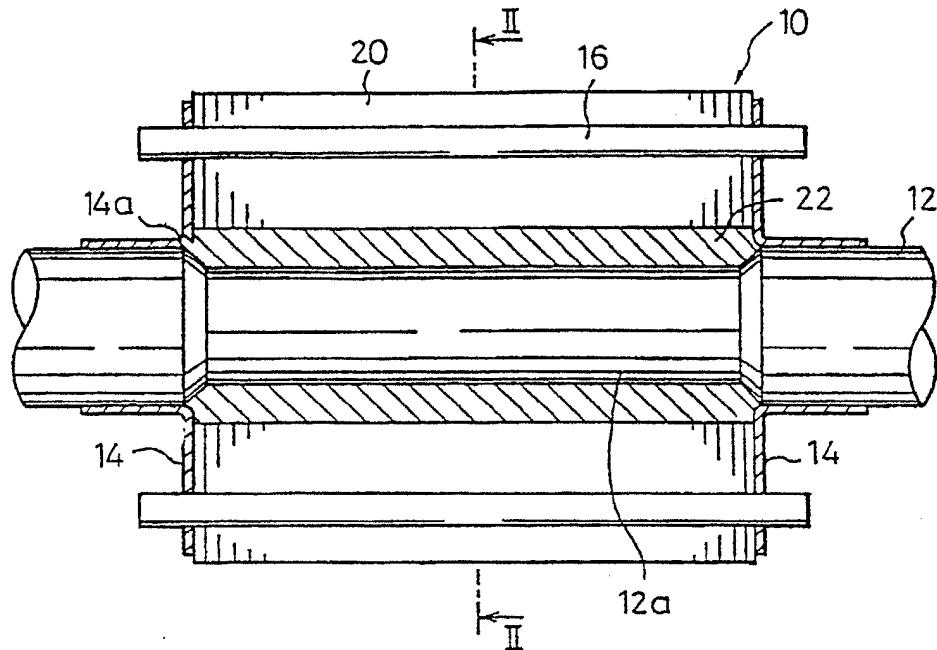


Fig. 2

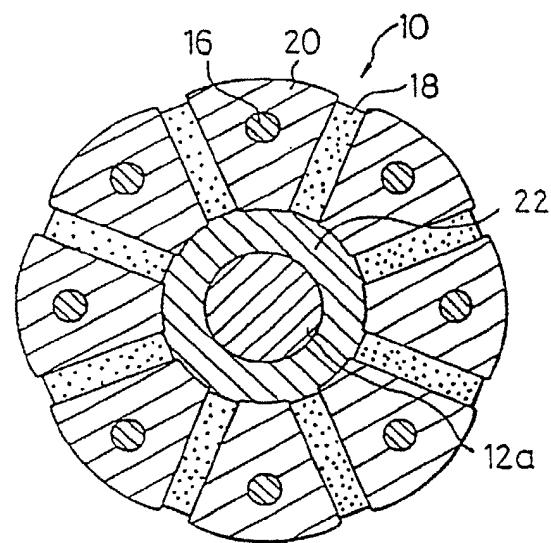


Fig. 3

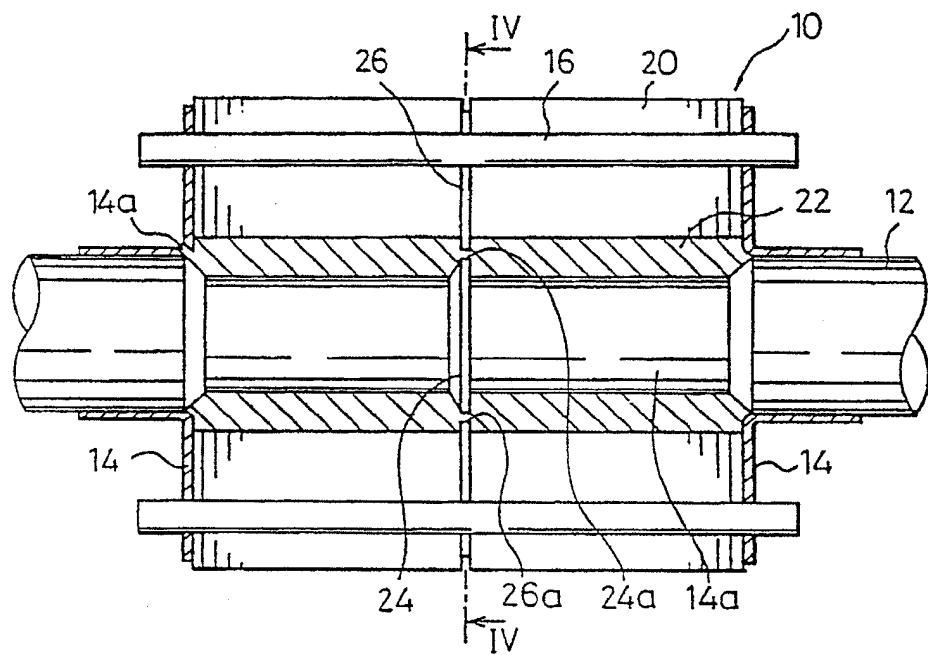
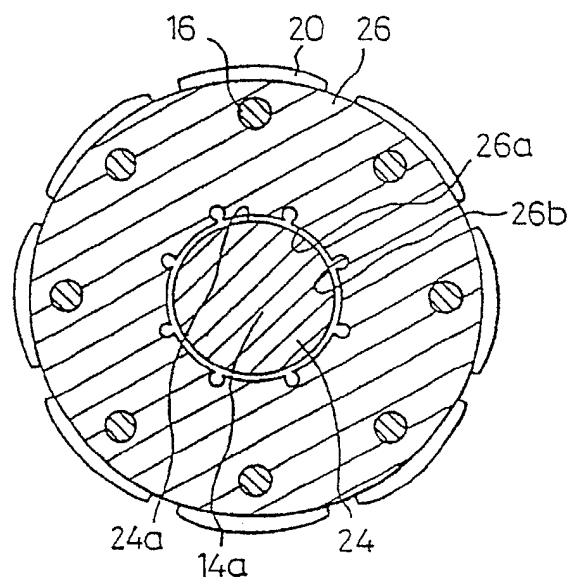


Fig. 4



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP90/00763

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>1)</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl<sup>5</sup> H02K1/27, 501

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>2)</sup>

| Classification System : | Classification Symbols |
|-------------------------|------------------------|
| IPC                     | H02K1/27, 501          |

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>3)</sup>

|                           |             |
|---------------------------|-------------|
| Jitsuyo Shinan Koho       | 1940 - 1990 |
| Kokai Jitsuyo Shinan Koho | 1972 - 1990 |

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>4)</sup>

| Category <sup>5)</sup> | Citation of Document, <sup>11)</sup> with indication, where appropriate, of the relevant passages <sup>12)</sup>  | Relevant to Claim No. <sup>13)</sup> |
|------------------------|---|--------------------------------------|
| Y                      | JP, A, 62-233053 (Fanuc Ltd.),<br>13 October 1987 (13. 10. 87),<br>Figs. 1a & 1b; line 5, lower left column,<br>page 288 to line 1, lower left column,<br>page 289 (Family: none) | 1 - 11                               |
| Y                      | JP, U, 49-74410 (Sankyo Seiki Mfg.<br>Co., Ltd.),<br>27 June 1974 (27. 06. 74),<br>Figs. 3 to 5; lines 1 to 13, right column<br>(Family: none)                                    | 1 - 11                               |

\* Special categories of cited documents: <sup>10)</sup>

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "Z" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

September 1, 1990 (01. 09. 90)

Date of Mailing of this International Search Report

September 17, 1990 (17. 09. 90)

International Searching Authority

Japanese Patent Office

Signature of Authorized Officer